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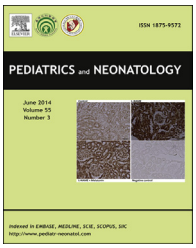

ORIGINAL ARTICLE

# Headache in the Pediatric Emergency Service: A Medical Center Experience

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**Key Words**
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*Background:* Headache is a common complaint in children and is one of the most common reasons for presentation at a pediatric emergency department (PED). This study described the etiologies of patients with headache seen in the PED and determined predictors of intracranial pathology (ICP) requiring urgent intervention. A secondary objective was to develop rapid, practical tools for screening headache in the PED.
*Methods:* We conducted a retrospective chart review of children who presented with a chief complaint of headache at the PED during 2008. First, we identified possible red flags in the patients' history or physical examination and neurological examination findings. Then, we recorded the brain computed tomography results.
*Results:* During the study period, 43,913 visits were made to the PED; in 409 (0.9%) patients, the chief complaint was headache. Acute viral, respiratory, and febrile illnesses comprised the most frequent cause of headache (59.9%). Six children (1.5%) had life-threatening ICP findings. In comparison with the group without ICP, the group with ICP had a significantly higher percentage of blurred vision ($p = 0.008$) and ataxia ($p = 0.002$).
*Conclusion:* Blurred vision and ataxia are the best clinical parameters to predict ICP findings.


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## 1. Introduction

Headache is a common complaint in children[1] and is one of most common reasons for presentation to a pediatric emergency department (PED).[2–7] The differential diagnosis is broad. The majority of headaches are benign and self-limited, and although life-threatening intracranial pathology (ICP), such as brain tumors or hemorrhage, is very rare, it does occur.[8] In addition, all forms of headache share a common pathway to some degree and the differential diagnosis may be difficult.

Brain computed tomography (CT) provides useful and rapid information on brain anatomy and pathology in children who reveal significant ICP. However, brain CT is expensive and is associated with radiation exposure.[9] The goal of this study was to describe the etiologies of patients presenting to the PED with headache and to identify predictors of ICP requiring urgent intervention. We also attempted to produce rapid and practical screening tools for headache in the PED.

## 2. Methods

### 2.1. Identification of patients

This was a retrospective chart review of children who presented with a chief complaint of headache at the PED of Chang Gung Memorial Hospital between January 1, 2008, and December 31, 2008. Chang Gung Memorial Hospital is a tertiary-care hospital in northern Taiwan. It serves patients from a broad demographic spectrum and a geographic region that includes urban, suburban, and rural areas. During the term of the study, 43,913 visits were made to the PED, and a computer-based search of these identified 409 children whose chief complaint was a headache. All patients were referred to the outpatient clinic for follow-up by a pediatric neurologist if they were not admitted through the PED.

### 2.2. Data collection and study design

The PED records were accessed through the hospital information system and a standardized data-collection form was completed, which recorded the following data: patient age and sex, headache and associated symptoms, physical examination and neurological examination findings, CT, and outcome. A list of red flags was generated from a literature review. First, we identified possible red flags in the history or physical and neurological examination findings. Then, we recorded the brain CT results. A headache was diagnosed, if possible, using the international headache classification. The final diagnosis was confirmed by a pediatric neurologist (J.-J.L.).

The ICP was defined as a potentially life-threatening space-occupying lesion that was confirmed by brain CT. Follow-up assessment was from records of clinic visits after PED discharge. This study was approved by the ethics committee of Chang Gung Memorial Hospital.

### 2.3. Statistical analyses

Comparisons of selected parameters were performed using the Chi-square test for categorical variables. All statistical analyses were performed using SPSS version 17.0 for Windows (SPSS Inc., Chicago, IL, USA). A $p$ value $<0.05$ was considered to indicate statistical significance.

## 3. Results

### 3.1. Demographics

During the study period, 43,913 visits were made to the PED; there were 409 (0.9%) patients whose chief complaint was a headache. There were 255 males and 154 females; the mean age was 9.2 years (standard deviation = 4.1 years; range 2.6–17.8 years). By age range, the numbers were 118 (28.9%) preschool children (<6 years), 167 (40.8%) primary school-age children (6–11 years), and 124 (30.3%) adolescents (12–17 years).

### 3.2. Etiologies

Data regarding final diagnoses are shown in Table 1. In total, 113 cases (27.6%) were diagnosed as having a primary headache, and 296 cases (72.4%) had a secondary headache. Acute viral, respiratory, and febrile illnesses represented the most frequent cause of headache (59.9%). Six children (1.5%) had ICP findings (Table 2). Three patients had newly diagnosed brain tumors and two had intracranial hemorrhages. Patient 5 had transtentorial herniation and died. His family refused an autopsy, so no further information was available for classification.

**Table 1** Headache etiologies in the pediatric emergency department.

| Diagnosis | Admitted group | Total |
|---|---|---|
| Primary headaches | | |
| Migraine | 10 (10.8) | 38 (9.3) |
| Primary headache, unclassified | 10 (10.8) | 75 (18.3) |
| Secondary headaches | | |
| Neurologic | — | — |
| VP shunt dysfunction | 2 (2.2) | 2 (0.5) |
| Seizures | 3 (3.2) | 5 (1.2) |
| Brain tumors | — | — |
| Known | 1 (1.1) | 2 (0.5) |
| Newly diagnosed | 3 (3.2) | 3 (0.7) |
| Meningitis | 20 (21.5) | 21 (5.1) |
| Post-traumatic | 2 (2.2) | 9 (2.2) |
| Intracerebral hemorrhage | 2 (2.2) | 2 (0.5) |
| Non-neurologic | — | — |
| Viral/respiratory/ febrile illness | 35 (37.6) | 245 (59.9) |
| Others* | 5 (5.4) | 7 (1.7) |
| Total | 93 (100) | 409 (100) |

Data are presented as $n$ (%).
VP = ventriculoperitoneal.
* Toothache, Wilson's disease, disorder of the eyes, systemic lupus erythematosus, Henoch–Schönlein purpura; one patient died.

**Table 2** Details of patients with intracranial pathological findings.

| No. | Age (y) | Sex | History, physical examination, and neurological examination | Brain CT |
|---|---|---|---|---|
| 1 | 15 | F | Headache, unsteady gait and blurred vision for 2 d | Brain tumor |
| 2 | 15 | F | Headache and blurred vision for 1 mo | Brain tumor |
| 3 | 15 | M | Headache and unsteady gait for 4 d | Intracranial hemorrhage |
| 4 | 12 | F | Headache, vomiting, and blurred vision for 1 d | Intracranial hemorrhage |
| 5 | 16 | M | Consciousness disturbance and unsteady gait for 1 d | Transtentorial hernia |
| 6 | 15 | M | Headache for 1 mo, awakened by headache | Brain tumor |

CT = computed tomography; F = female; M = male.

### 3.3. Use of CT

Forty (10%) of the 409 children underwent brain CT after the initial evaluation. Reasons for brain CT are listed in Table 3. The most common indication for brain CT was vomiting in 50% of the patients. Table 4 lists the results of the CT scans. Of them, 23 (57.5%) were apparently normal, and the most common abnormal finding was sinusitis (7 children, 17.5%). Six (15%) of the 40 children had ICP findings.

### 3.4. Outcomes

Ninety-three patients were admitted to the hospital for further investigations (Table 1), an admission rate of 22.7%. After discharge from the PED, 341 (83%) patients were followed-up at our outpatient department or PED. Apart from the six children with ICP, one child had left-sided weakness after enterovirus meningitis. No other patient had neurological sequelae after PED discharge. No physician working in the PED in 2008 was involved in any lawsuit.

### 3.5. Predictors of ICP

We divided the 40 children who underwent brain CT into two groups—children with and without ICP. We compared the clinical histories and results of neurological examinations of children with and without ICP to determine predictors of ICP requiring urgent intervention. In comparison with the group without ICP, the group with ICP had a significantly higher percentage of blurred vision ($p = 0.008$) and ataxia ($p = 0.002$). Four children had blurred vision, three had ICP (Table 2), and one had nearsightedness; her headaches subsided after wearing corrective glasses.

**Table 3** Clinical features of headache in children who underwent brain CT between those with and without ICP.

| Variables | With ICP ($n = 6$) | Without ICP ($n = 34$) | $p$ |
|---|---|---|---|
| Vomiting | 2 | 18 | 0.66 |
| Headache characteristics | 1 | 12 | 0.64 |
| Chronic progressive headache | 0 | 7 | 0.57 |
| Headache awakens the child | 1 | 3 | 0.49 |
| Worst headache | 0 | 2 | 1.00 |
| Blurred vision | 3 | 1 | 0.008 |
| Ataxia/incoordination | 3 | 0 | 0.002 |
| Altered mental status | 1 | 1 | 0.28 |
| Seizure | 0 | 1 | > 0.99 |
| Trauma | 0 | 5 | > 0.99 |
| VP shunt insertion history | 0 | 2 | > 0.99 |

Data are presented as $n$ (%).
CT = computed tomography; ICP = intracranial pathology; VP = ventriculoperitoneal.

## 4. Discussion

Few studies have focused on headache in the PED.[2–7] In our study, headache accounted for 0.9% of PED visits, similar to reported rates of 0.7–1.0%.[3,5,6] In our study, the vast majority of acute headaches in children are attributable to benign and self-limiting diseases, such as upper respiratory illnesses or fevers. We found six (1.5%) children with ICP findings: three newly diagnosed brain tumors, two intracranial hemorrhages, and one transtentorial hernia. On the basis of an initial history and physical examination findings, 90% of patients had clearly identifiable causes for their headaches. The other 10% underwent CT scans.

Our data suggests that neurological signs and symptoms are vital for identifying children presenting with headache who are more likely to have ICP.[7,10] We narrowed them to two key points, namely, questioning regarding visual disturbances and observing gait.

Diagnosis of headache in a child is difficult,[11] especially in the PED. Papilledema, paralysis, and altered mental status showed a strong positive predictive value for ICP.[1] It may not be difficult to recognize paralysis and altered mental status in the PED; however, even for experienced physicians, performing ophthalmoscopy to identify papilledema can be challenging.[12] In the PED, detailed headache

**Table 4** Brain CT results.

| Radiographic results | $n$ (%) |
|---|---|
| Normal | 23 (57.5) |
| Sinusitis | 7 (17.5) |
| Tumor | 3 (7.5) |
| VP shunt malfunction | 2 (5.0) |
| ICH | 2 (5.0) |
| Miscellaneous* | 3 (7.5) |
| Total | 40 (100) |

CT = computed tomography; ICH = intracerebral hemorrhage; VP = ventriculoperitoneal.
* Prominent pituitary gland; calcification in bilateral frontal lobes, caudate nucleus, and putamen; transtentorial hernia.

history and characteristics, family migraine history, and thorough physical and neurological examinations are less readily available than in office-based practice. The majority of ED physicians confronting children are often trained in adult care,[13,14] and they have varying degrees of skill and experience.

Meningitis is inflammation of the thin tissue that surrounds the brain and spinal cord. It is an important differential diagnosis element for headache, which accounted for 21.5% of the admitted patients in our study. Although a patient with meningitis may have no space-occupying lesion (i.e., ICP), it can still be a life-threatening disease. Clinical assessment and cerebrospinal fluid analysis are necessary to establish a diagnosis of meningitis.

Blurred vision, or a lack of sharpness of vision, was an important clinical predictor of ICP in our study. A wide range of causes for blurred vision was seen, such as nearsightedness, migraine, and genuine ICP. At the ED, the child and parents seldom mention sharpness of vision. Once blurred vision is identified, it should be put in terms of more specific physical findings, such as decreased visual acuity, defected visual field, papilledema, or other visual symptomatology.

Ataxia is poor coordination and unsteadiness, which was also an important clinical predictor of ICP in our study. Ataxia results from dysfunction in the cerebellum and its connections, the posterior column of the spinal cord, or peripheral nerves.[15] In children with headache accompanied by ataxia, a neuroimaging study should be considered.[16]

It might be argued that brain CT did not make a useful contribution to the acute management of these children. It is reasonable that physicians order CT due to the fear of missing uncommon life-threatening events or of incurring potential medicolegal liability. In the United States, between 2005 and 2008, CT was performed in 20—28% of children with headaches seen in the ED.[17] As yet, no clinical feature that supports not ordering CT for children with a headache seen in the PED setting has been identified.[7,10] Ahmed et al[18] reported that 0.4% of neurologically normal children with headache had significant brain abnormalities. In our study, Patient 6 had red flags but no abnormality on neurological examination.

Brain CT provides useful, rapid information on brain anatomy and pathology in children with headaches. The CT is an important component of the evaluation and diagnosis of children with neurological complaints in the PED. A meta-analysis revealed that cases in which CT was not available for diagnosis had a higher rate of sudden death.[19] In Ireland, Lynch and Brett[20] suggested that much of the decrease in fatal headaches was attributable to the use of CT. However, brain CT is expensive and its use in every child with a headache is simply impractical. Another important issue is the risk of cancer due to exposure to ionizing radiation. Pearce et al[9] estimated that there was one additional case of leukemia and one additional case of brain tumor for every 10,000 CTs performed.

In our study, 50% of the children underwent brain CT because of vomiting. Headache plus vomiting is a sign of increased intracranial pressure. However, migraine also presents as headache plus nausea/vomiting. A systematic review showed that vomiting increased the likelihood of a patient having serious ICP.[21] However, no high-quality study has assessed headache and vomiting in children. Therefore, the role of a history of vomiting in clinical decision making is uncertain.

Children with headache often have some comorbidity, such as hypertension or anxiety,[22] so consultation with other subspecialties is important.[23] Most primary headache patients suffer from headache intermittently and visit the PED frequently prior to a diagnosis. Scagni and Pagliero[6] reported that referring a patient to a pediatric neurologist might limit repeated visits to the PED and avoid unnecessary investigations.

We acknowledge three potential limitations to our study. First, this was a retrospective study. We were confined to the recorded data, which could not guarantee identification of historical or neurological findings. Second, follow-up was incomplete. In total, 17% of patients were lost to follow-up. However, no physician working at the PED in 2008 was involved in any lawsuit. From this, we assume that those lost to follow-up did not have life-threatening intracranial pathologies. Finally, because our patient series were collected at a single tertiary-care hospital, the findings may not be representative of the general population. However, all six patients with ICP were referred from other hospitals. Thus, observation of gait and questions about visual disturbances are useful to PED physicians who are confronted with children with headaches.

In conclusion, most acute headaches in children were attributable to benign and self-limited diseases, such as upper respiratory illnesses or fevers. Collaboration with a pediatric neurologist is important because this might limit repeated visits to the PED and avoid unnecessary investigations. Blurred vision and ataxia are the best clinical parameters for predicting ICP findings. No 100% risk-free algorithm to exclude those without ICP seen in the PED is as yet available.

## Conflict of interest

The authors state that there is no conflict of interest regarding the publication of this article.

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